

Gulf of Mexico Coastal Condition

The overall condition of Gulf Coast estuaries is fair (Figure 5-1). Thirty-five percent of the estuarine area shows indications of impaired aquatic life use, and 14% shows indications of impaired human use (Figure 5-2). Twenty percent of the assessed estuaries are in good ecological condition. In these areas of good condition, data were collected during the most stressful period of the year, and neither environmental stressors (e.g., nutrients, contaminants) nor aquatic life communities showed any evidence of degradation. Thirty-nine percent of estuarine area along the Gulf of Mexico was assessed as threatened (in fair condition). The five Gulf states—Florida, Alabama, Mississippi, Louisiana, and Texas—collected environmental stressor and response data from 191 locations from Florida Bay, Florida, to Laguna Madre, Texas, in 2000 (Figure 5-3).

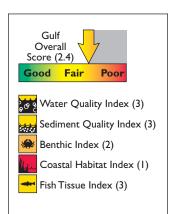


Figure 5-1. The overall condition of Gulf Coast estuaries is fair.

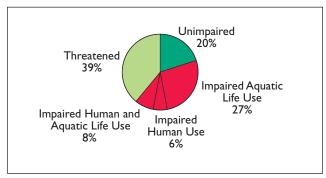


Figure 5-2. Gulf Coast estuarine condition (U.S. EPA/NCA).

Gulf Coast estuaries provide critical feeding, spawning, and nursery habitats for a rich assemblage of fish, wildlife, and plant species. Gulf Coast wetlands provide essential habitat for shorebirds, colonial nesting birds, and migratory waterfowl. The Gulf Coast is also home to an incredible array of indigenous flora and fauna, including endangered species such as sea turtles, the Gulf sturgeon, the Perdido Key beach mouse, the manatee, the white-topped pitcher plant, and the red-cockaded woodpecker. Gulf Coast estuaries support SAV communities that stabilize shorelines from erosion, reduce nonpoint source loadings, improve water clarity, and provide wildlife habitat.

Gulf Coast estuaries are among the most productive natural systems, producing more food per acre than the most productive midwestern farmland. The Gulf Coast region is second only to Alaska for domestic landings of commercial fish and shellfish, with 816,466 mt in 2000, worth more than \$900 million (NMFS, personal communication). Shrimp landings in the Gulf of Mexico accounted for 80% of the total U.S. shrimp landings in 2000 (127,006 mt).



Shrimp boats viewed over old, barnacle-encrusted pilings at Conn Brown Harbor, Aransas Pass, Texas (Mr. William B. Folsom, NOAA, NMFS).

The part of Cayo del Oso Creek that empties into Corpus Christi Bay, Corpus Christi Bay, Texas (Mr. William B. Folsom, NOAA, NMFS).



Figure 5-3. Gulf Coast sampling stations for the 2000 NCA Program surveys (U.S. EPA/NCA).

The population of coastal counties in the Gulf Coast region increased more than 100% between 1960 and 2000 (U.S. Census Bureau, 2003; Figure 5-4). EMAP focused its coastal monitoring efforts on Gulf Coast estuaries from 1991 to 1999 (Macauley et al., 1999; U.S. EPA, 1999). The Joint Gulf States Comprehensive Monitoring Program (GMP, 2000) began in 2000, in conjunction with EPA's Coastal 2000 Program. This partnership has continued as part of the NCA Program, with coastal monitoring being conducted by the five Gulf states through 2004. In addition, since the late 1980s, NOAA's NS&T Program has collected contaminant bioavailability and sediment toxicity data from several Gulf Coast locations (Long et al., 1996).

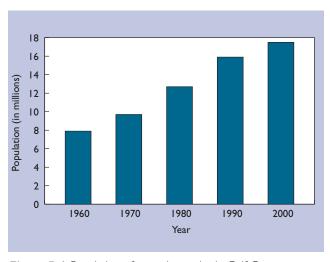


Figure 5-4. Population of coastal counties in Gulf Coast states from 1960 to 2000 (U.S. Census Bureau, 2003).

Coastal Monitoring Data

Water Quality Index

A water quality index was developed for Gulf Coast estuaries, using information from five indicators (DIN, DIP, chlorophyll a, water clarity, and dissolved oxygen). Based on the 2000 NCA survey results, the water quality index is rated fair for Gulf Coast estuaries. In NOAA's Estuarine Eutrophication Survey (NOAA, 1999), the Gulf of Mexico was ranked poor for eutrophic condition, with an estimated 38% of the estuarine area having a high expression of eutrophication. The NCA survey in 2000 showed few estuaries in the Gulf Coast with poor water quality (9%); however, most Gulf Coast estuaries exhibited fair to poor water quality conditions (51%) (Figure 5-5). Estuaries with poor water quality conditions were found in all five states, but the contributing factors differed among states. In Texas and Louisiana, poor water clarity and high concentrations of DIP contributed to poor water quality. In Florida and Mississippi, poor water clarity and high chlorophyll concentrations were the major contributors. Only the Houston Ship Channel in Texas and the Back Bay of Biloxi in Mississippi had high concentrations of both nitrogen and phosphorus. The Perdido River in Alabama showed both hypoxia and high chlorophyll a concentrations.



Coral reef researchers Carl Beaver and Hector Guittierez secure a rack of tiles to the exposed reef rock (Ed Enns).

Nutrients: Nitrogen and Phosphorous

DIN concentrations in the surface waters of Gulf Coast estuaries are rated good, but DIP concentrations are rated fair. High concentrations of DIN (> 0.5 mg/L) occurred in 2% of the estuarine area (Figure 5-6). Florida Bay sites were rated poor if DIN exceeded 0.1 mg/L or if DIP exceeded 0.01 mg/L. This modification was made to comply with lower expectations for nutrients in tropical and subtropical waters. Only three sites had DIN concentrations above 0.5 mg/L: Houston Ship Channel, Texas; Calcasieu River, Louisiana; and Back Bay of Biloxi, Mississippi.

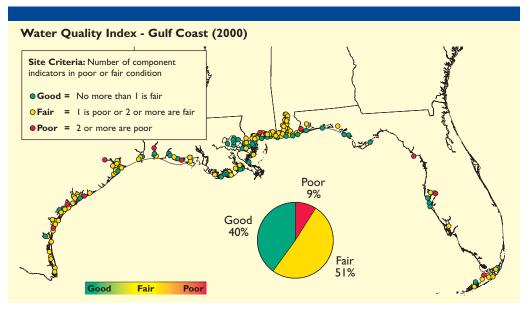


Figure 5-5. Water quality index data for Gulf Coast estuaries (U.S. EPA/NCA).

The sampling conducted in the EPA NCA Program has been designed to estimate the percent of estuarine area (nationally or in a region or state) in varying conditions and is displayed as pie diagrams. Many of the figures in this report illustrate environmental measurements made at specific locations (colored dots on maps); however, these dots (color) represent the value of the indicator specifically at the time of sampling. Additional sampling may be required to define variability and to confirm impairment or the lack of impairment at specific locations.

Elevated DIN concentrations are not expected to occur during the summer in Gulf Coast waters because freshwater input is usually lower and dissolved nutrients are used more rapidly by phytoplankton during the summer. Elevated DIP concentrations (> 0.05 mg/L) occurred in 11% of Gulf Coast estuaries (Figure 5-7). Tampa Bay and Charlotte Harbor, Florida, have naturally high DIP concentrations because of geological formations of phosphate rock in their watersheds, but they also have significant anthropogenic sources of DIP in their watersheds.

Potential for Misinterpretation of Conditions for States with Smaller Coastlines

Alabama and Mississippi resource agencies are concerned that the figures presented in the Coastal Monitoring Data section of this chapter could potentially represent their estuaries unfairly. Both states have at least fifty locations that were sampled in the NCA Program's 2000 survey; however, because of the high density of these sites and the small estuarine resources of these states, even one or two sites rated poor (red circles) give the appearance of poor condition dominating a large portion of the entire coast of these states. Although showing the entire Gulf Coast region in a single graphic is consistent with the goals of this report, these displays do not provide a detailed view of all data, particularly for Alabama, Mississippi, and eastern Louisiana.

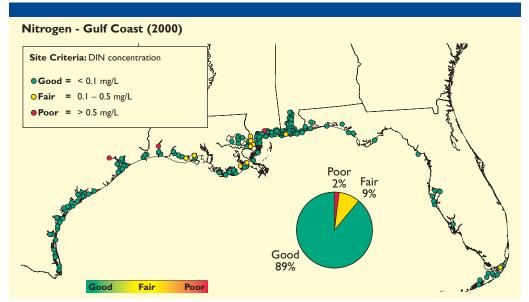


Figure 5-6. DIN concentration data for Gulf Coast estuaries (U.S. EPA/NCA).

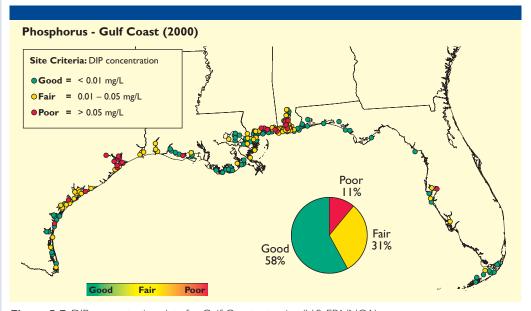


Figure 5-7. DIP concentration data for Gulf Coast estuaries (U.S. EPA/NCA).



The Gulf of Mexico Seagrass Status and Trends **Summary Report**

The Gulf of Mexico Program (GMP) is a network of citizens dedicated to promoting the economic health of the region by managing and protecting the resources of the Gulf of Mexico. Although administered by EPA, the GMP engages many organizations across the Gulf Coast region to implement and lead tangible projects that are environmentally and economically



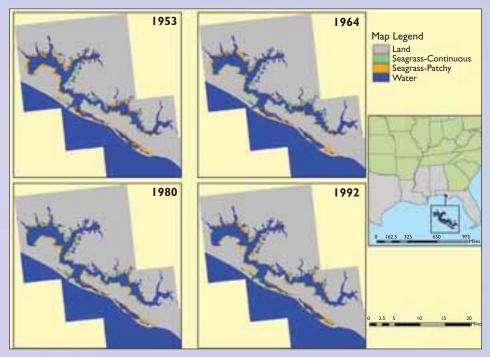
sound. The GMP includes representatives from state and federal agencies, nonprofit organizations, the scientific community, business and industry, and an organized citizens group. These members are appointed by the five Gulf state governors. The GMP focuses on three ecological issues: (1) public health, (2) excess nutrient enrichment, and (3) habitat degradation and loss, including the introduction of nonindigenous species.

The GMP has long recognized seagrasses, estuaries, and coastal wetlands as vital in providing food and shelter for plants and animals, improving water quality, sediment filtration, and flood and erosion control. In 1999, the GMP's Habitat Team set a goal to restore, enhance, or protect 20,000 acres of important coastal habitats of the Gulf by 2009. The Habitat Team, recognizing that seagrass beds are some of the most productive habitats in nearshore waters, set a goal to produce a Gulf-wide Seagrass Status and Trends (S&T) Summary Report. The purpose of the Summary Report is to provide current baseline information on the status of seagrasses in the Gulf of Mexico.

To produce this report, the GMP's Habitat Team formed a Seagrass Subcommittee, consisting of over 30 Gulf Coast seagrass scientists and environmental managers. Committee members provided data on seagrass maps, seagrass S&T, causes of change in seagrass acreage, monitoring activities, and restoration efforts important to their area. The USGS National Wetlands Research Center also provided extensive support in the production of data, maps, and editing that will comprise this summary. This map depicts total seagrass change from 1953 until 1992 for St. Andrews Bay, Florida.

In 1992, the total seagrass coverage in waters of the Gulf was estimated at 2.52 million acres (Duke and Kruczynski, 1992). The updated summary will provide a baseline for the status of seagrasses in the Gulf, as well as provide specific area and statewide seagrass information to scientists, managers, and decision makers.

A Seagrass Outreach document, written in layman's terms and developed for the general public, politicians, and Gulf of Mexico stakeholders, will accompany the Seagrass S&T Summary Report. Additional information will be available on the USGS National Wetlands Research Center's Web site at http://www.nwrc.usgs.gov and the GMP Web site at http://www.epa.gov/gmpo/.



Changes in seagrass coverage in St. Andrews Bay Systems, Florida, from 1953-1992 (produced by the USGS National Wetlands Research Center for the NCCRII).

Chlorophyll a

Chlorophyll a concentrations in Gulf Coast estuaries are rated good. Eight percent of the estuarine area in the Gulf Coast region had high concentrations of chlorophyll a (Figure 5-8). Concentrations above 20 ug/L occurred in Mississippi, Alabama, and Florida estuaries. Sites in Florida Bay were rated poor if concentrations of chlorophyll a were greater than 5 µg/L. This modification was made to comply with lower expectations for chlorophyll in tropical and subtropical waters.

Water Clarity

Water clarity in Gulf Coast estuaries is fair. The amount of ambient light that reaches certain depths underwater can be measured to provide an estimate of water clarity in coastal waters. Water clarity is affected by suspended sediments, particulate matter, and phytoplankton. A minimum level of water clarity is necessary to sustain SAV beds. Expectations for water clarity to sustain SAV vary across the Gulf of Mexico. In Florida Bay and Laguna Madre, for example, SAV beds flourish, and water clarity is usually high. In contrast, except for some widgeongrass, and duckweed, seagrass, and rooted SAV habitats rarely exist in estuaries in Louisiana because these waters are naturally turbid. Water clarity is expected to be low in Louisiana, Alabama, and Mississippi estuaries, as well as other northern Gulf Coast estuaries.

Water clarity was estimated from an index of expected conditions by comparing Secchi depth with a light-extinction coefficient. Gulf Coast estuaries were classified based on regional expectations for light penetration related to SAV distribution. Water clarity was determined to be good, fair, or poor by comparing a sample light-extinction coefficient calculated from the measured Secchi depth to a range of reference lightextinction coefficients. For approximately 29% of Gulf Coast estuaries, the water clarity measured was less than the reference standard (Figure 5-9). Lower than expected water clarity occurred throughout Gulf Coast estuaries, but was concentrated in the Coastal Bend region of Texas, Mississippi, and south Florida.

Although the current NCA approach used to assess water clarity is an improvement over the previous effort, it still may reach inappropriate conclusions regarding water clarity for parts of the Gulf Coast. Many of the Gulf Coast regions have high natural silt and suspended sediment loads. To modify the water clarity approach for this natural condition, researchers adjusted the approach by the "expected" water clarity levels to lower levels for much of the Gulf Coast. While this adjustment appears to have been successful for much of the Florida, Alabama, Mississippi, and Louisiana coasts, further adjustments may be necessary for Mississippi Sound and the Texas coast.

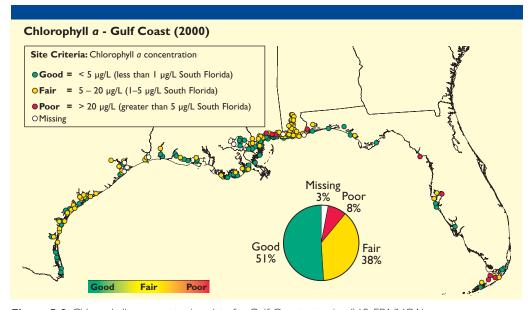


Figure 5-8. Chlorophyll a concentration data for Gulf Coast estuaries (U.S. EPA/NCA).

Dissolved Oxygen

Dissolved oxygen conditions in Gulf Coast estuaries are good. NCA estimates for Gulf Coast estuaries show that less than 1% of the bottom waters exhibit hypoxia (< 2 mg/L dissolved oxygen) in late summer (Figure 5-10). These areas are largely associated with Mobile Bay, Alabama, which experiences regular hypoxic events during the summer that often culminate in "jubilees." Occurrences of jubilees, when fish and crabs try to escape hypoxia by migrating to the edges of Mobile Bay, have been recorded since colonial times (May, 1973) and are most likely natural events. Hypoxia in Gulf Coast estuaries results from stratification, eutrophication, or a combination of these two conditions.

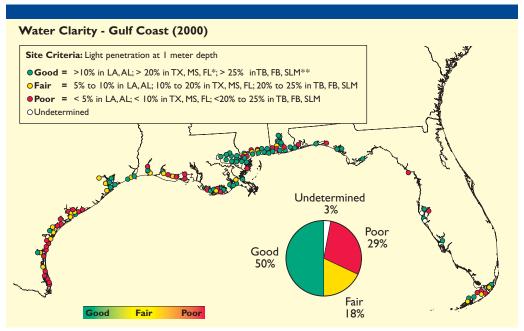


Figure 5-9. Water clarity condition for Gulf Coast estuaries (*FL = Florida Gulf of Mexico estuaries except Tampa Bay [TB] and Florida Bay [FB]; **SLM = southern Laguna Madre) (U.S. EPA/NCA).

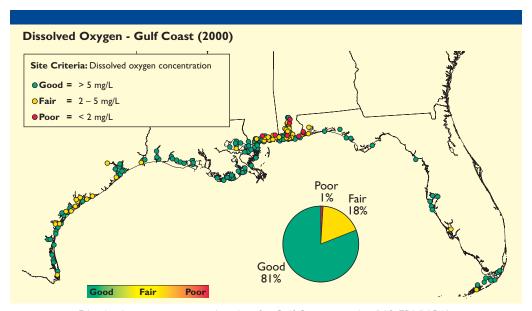


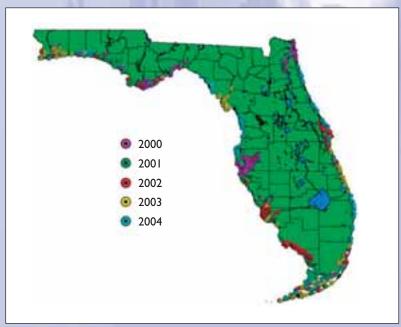
Figure 5-10. Dissolved oxygen concentration data for Gulf Coast estuaries (U.S. EPA/NCA).

highlight

Florida's Inshore Marine Monitoring and Assessment Program (IMAP)

Inshore marine resources are one of Florida's most valuable assets. These unique and diverse waters range from major embayments and lagoons to smaller river-mouth estuaries, tidal marshes, and mangrove forests that merge directly with the sea. The Inshore Marine Monitoring and Assessment Program (IMAP) is a collaborative project between EPA and the Florida Marine Research Institute (FMRI) designed to assess the environmental condition of Florida's inshore waters using established environmental indicators. IMAP serves as the inshore marine component of an Integrated Water Resource Monitoring Network (IWRMN). Within this network, Florida's Department of Environmental Protection Ambient Monitoring Program samples freshwater lakes, streams, and groundwater, while IMAP samples estuaries. These sampling schedules are coordinated so that both programs measure the same regions during the same years. This integrated approach allows the state of Florida to comprehensively assess the quality of all water resources within a region.

IMAP's coastal water survey design operates both regionally and statewide. The regions correspond to Florida's five water management districts. A probability-based survey design is used to select sample locations, applying latitude-longitude coordinates to identify randomly selected points within a network of hexagonal grids.



Florida IMAP sampling design, 2000-2004 (FMRI, 2003, unpublished data).

IMAP's environmental data represent the quality of the state's inshore waters and are collected from 180 sites every year (30 sites statewide, and 30 sites per one sampling unit in each water management district). Sampling is conducted during late summer when inshore resources are under significant stress and conditions are relatively stable. Physical-chemical indicators include water quality (e.g., dissolved oxygen, salinity, temperature, nutrients, and chlorophyll), sediment chemistry, and fish tissue chemistry. IMAP's biological indicators integrate environmental conditions over larger spatial and temporal scales. These indicators include fish and benthic invertebrate community composition, individual fish health, seagrass diversity and coverage, and the presence of toxic algae.

In 2000, IMAP sampled Florida's Apalachicola Bay, Lake Worth, Suwannee River, Tampa Bay, and the Nassau, St. Marys, and St. Johns rivers, as well as 30 other sites statewide. Hypoxic conditions, defined by dissolved oxygen levels <2 mg/L, were not observed in Florida during the summer of 2000. Sediment chemistry samples were collected only at the statewide sites, with several metals measured at levels above the threshold effects level (MacDonald, 1994), indicating the potential for adverse biological effects. These metals include mercury, arsenic, chromium, lead, nickel, and copper, although high concentrations were observed at only five sites statewide. Most organic compounds were not detected in Florida sediments. Biological samples included fish, benthic macroinvertebrates, seagrass, and toxic algae. A comprehensive assessment of the ecological condition of Florida's coastal waters will be completed at the end of the 5-year sampling period.



IMAP field crew using a seine to sample fish and invertebrates (photo courtesy of FMRI, 2003).

Although hypoxia is a relatively local occurrence in Gulf Coast estuaries, accounting for less than 1% of the estuarine bottom waters, the occurrence of hypoxia in the Gulf's shelf waters is much more significant. The Gulf of Mexico hypoxic zone, which occurs in waters on the Louisiana shelf to the West of the Mississippi River delta, is the second-largest area of oxygen-depleted waters in the world (Rabalais et al., 2002). From 1985 to 1992, the areal extent of bottom hypoxic waters in midsummer averaged 3,000 square miles; from 1993 to 1997, the average area doubled to 6,500 square miles (Rabalais et al., 1999). In the summer of 2000, the area of the hypoxic zone was reduced to 1,700 square miles, following severe drought conditions in the Mississippi River watershed (Figure 5-11). By 2002, the hypoxic zone had again increased in size to 8,500 square miles. Current hypotheses speculate that the hypoxic zone

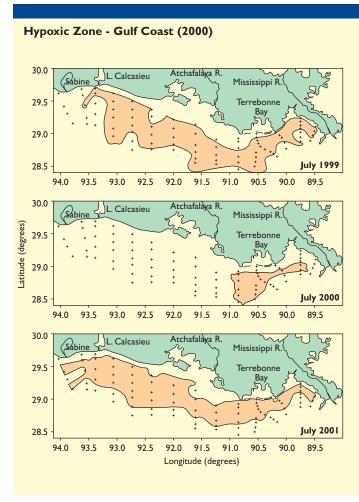


Figure 5-11. Spatial extent of the Gulf Coast hypoxic zone during July 1999, 2000, and 2001 (U.S. EPA/NCA, based on data provided by Nancy Rabalais, 2003, personal communication).

results from (1) water column stratification driven by weather and river flow and (2) decomposition of organic matter in bottom waters (Rabalais et al., 2002). Organic matter enters the Gulf of Mexico from the Mississippi River as either river-borne organic matter or phytoplankton growth stimulated by riverine-delivered nutrients (CENR, 2000). Annual variability in the area of the hypoxic zone is most likely related to rainfall in the Mississippi River watershed and its effect on river flow. Sediment cores from the hypoxic zone show that shelf algal production was significantly lower in the first half of the twentieth century, suggesting that anthropogenic changes to the basin and its discharges have resulted in the increased hypoxia (CENR, 2000).

Since 1980, the Mississippi-Atchafalaya River basins, which discharge to this portion of the Louisiana shelf, have averaged 1.6 million mt of total nitrogen load annually (Goolsby et al., 1999). Nitrate load, which constitutes the bulk of total nitrogen load from the Mississippi River basin to the Gulf of Mexico, has increased 300% since 1970. Nonpoint sources contribute most of the nitrogen load to the Gulf of Mexico, particularly agricultural areas north of the confluence of the Ohio and Mississippi rivers (Goolsby et al., 1999). Gulf of Mexico ecosystems and fisheries are affected by the widespread hypoxia. Mobile organisms leave the hypoxic zone for more oxygen-rich waters, and frequently, those organisms that cannot leave die.

Estimates of Gulf of Mexico shelf hypoxia have not been included in the estimates of Gulf Coast estuaries hypoxia; consequently, this good rating for dissolved oxygen in Gulf Coast estuaries should not be considered indicative of offshore conditions.



White ibis feed in the mangrove areas that support a myriad of small crustaceans and fish on which they feed (Paul Goetz).



Sediment Quality Index

The condition of Gulf Coast estuarine sediment is fair, with 12% of the area exceeding thresholds for sediment toxicity, sediment contaminants, or sediment TOC (Figure 5-12).

Sediment Toxicity

Sediment toxicity data from the NCA show that less than 1% of Gulf Coast sediments are toxic (i.e., cause

greater than 20% mortality in test organisms) (Figure 5-13). A high proportion (38%) of the toxicity data is missing because of various quality control issues. With this high level of missing data (38%), the proportion of sediments that are toxic could be greater than 1%. Previous bioeffects surveys by NOAA showed less than 1% toxicity in large estuaries in the Gulf (Long et al., 1996).

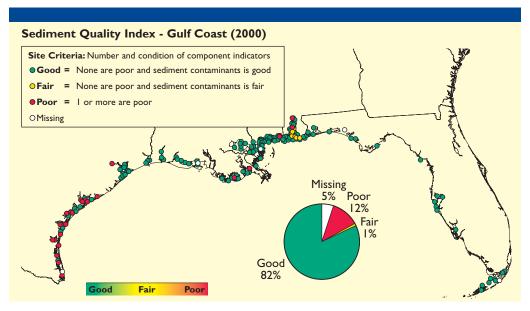


Figure 5-12. Sediment quality index data for Gulf Coast estuaries (U.S. EPA/NCA).

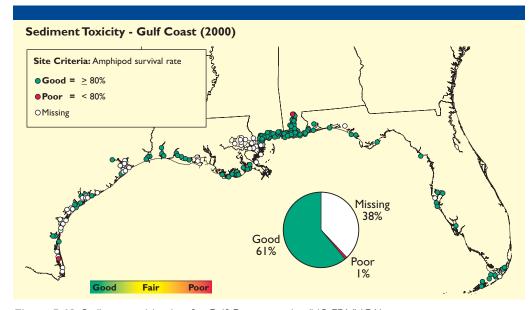


Figure 5-13. Sediment toxicity data for Gulf Coast estuaries (U.S. EPA/NCA).

Sediment Contaminants

Sediment contaminant concentrations greater than ERM guidelines (Long et al., 1995) were observed primarily in Texas estuaries (Figure 5-14).

Concentrations of five or more sediment contaminants that were greater than ERL guidelines (Long et al., 1995) occurred only in Mobile Bay, Alabama. At least one metal exceeded ERL guidelines in 28% of the estuarine area, whereas only 12% to 14 % of the area

exceeded guidelines for at least one pesticide or PCB. PAHs rarely exceeded ERL guidelines in Gulf Coast estuaries. No contaminant exceedances were observed in Florida's Gulf Coast estuaries.

Sediment Total Organic Carbon

Only 2% of the estuarine area in the Gulf Coast has high levels of sediment TOC (TOC > 5%; Figure 5-15).

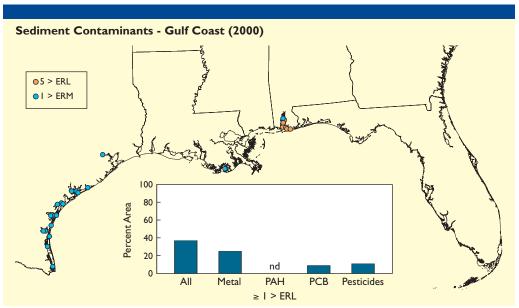


Figure 5-14. Gulf Coast estuary stations with at least one contaminant greater than ERM or at least five contaminants greater than ERL. The bar chart shows the percent area of Gulf Coast estuaries with at least one contaminant greater than ERL for separate categories of contaminants (U.S. EPA/NCA).

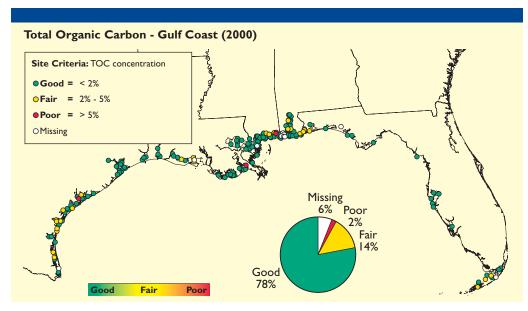


Figure 5-15. Sediment TOC concentration data for Gulf Coast estuaries (U.S. EPA/NCA).

Sediment Contaminant Criteria (Long et al., 1995)

ERM (Effects Range Median)—Determined for each chemical as the 50th percentile (median) in a database of ascending concentrations associated with adverse biological effects.

ERL (Effects Range Low)—Determined values for each chemical as the 10th percentile in a database of ascending concentrations associated with adverse biological effects.

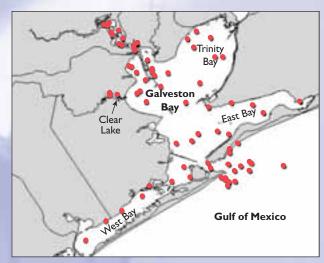


Sediment Toxicity in Galveston Bay

As part of NOAA's NS&T Program, bioeffects surveys have been conducted in several major estuarine systems. Results from 22 surveys were summarized in the first National Coastal Condition Report; however, results from Galveston Bay were not available for publication until now.

Sediment contamination and toxicity were measured over the entire Galveston Bay area, from San Jacinto Park in the north out into the Gulf of Mexico, Trinity Bay, East and West Bay, and Clear Lake. In 1996, 75 stations were sampled using a stratified-randomized design within 21 different sediment layers. Bioassay tests of survival of amphipods exposed to whole sediment for 10 days showed no toxicity at any site. Fertilization tests of sea urchin eggs exposed to pore waters and tests of bioluminescence by bacteria exposed to organic extracts of sediment did show toxic

responses. Over the 598.5 square miles of Galveston Bay, no whole sediment samples were toxic to amphipods; pore water extracted from 45% of the sites affected sea urchin fertilization; and organic extracts from 87% affected bacterial bioluminescence. All of these tests require some sediment manipulation prior to testing and do not precisely replicate actual environmental exposures. Required procedures for obtaining samples used in laboratory bioassay tests create conditions unlike those of actual exposures; thus, toxicity measured by these techniques does not necessarily represent the level of actual harm to organisms in the field.



Sediment sampling sites in Galveston Bay study (Harmon et al., 2003).

Conversely, the existing indigenous BMC at a site does experience real exposures. Among the 75 stations, a generally increasing gradient existed from north to south in the various ways of summarizing BMC structure, such as numbers of species, density of individuals and species, and species diversity. The lowest values for the BMC measures were found in Clear Lake. Using a criterion of benthic degradation as indicative of five or fewer species per sediment sample, 8% of Galveston Bay sediment samples would be considered degraded.

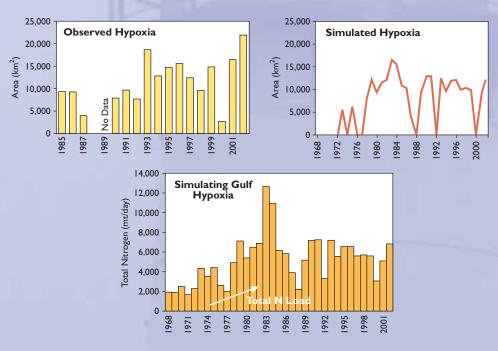
For more information, visit http://nsandt.noaa.gov/index_bioeffect.htm.

highlight

Gulf of Mexico Hypoxia Study

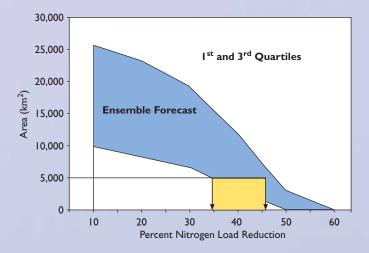
For 17 years, routine measurements of dissolved oxygen and nitrogen concentrations, coupled with computer modeling, have resulted in forecasts of Midwestern nitrogen usage effect on the northern Gulf of Mexico. Each spring and summer, extensive hypoxic regions develop in the Gulf of Mexico with bottom dissolved oxygen levels below 2 mg/L. These regions have recently extended from the mouth of the Mississippi River 372 miles westward past the Texas border. These hypoxic regions averaged 3,205 square miles from 1985 to 1992 and increased to an average of 16,178 square miles from 1993 to 2001.

The effects of nutrient loading from the Mississippi River basin on the areal extent of hypoxia were examined using a novel application of a river dissolved oxygen model. The model, driven by river nitrogen load and a simple parameterization of ocean dynamics, reproduced 17 years of observed hypoxia location and extent, sub-pycnocline oxygen consumption, and cross-pycnocline oxygen flux. The model results correlate to those of the observed hypoxic zone areal extents from 1985 to 2002, with a few notable exceptions (see figure below). Hindcasts, using nitrogen loads between 1968 and 1984, suggest that before the mid-1970s, the nitrogen load was not sufficient to produce significant areas of oxygen-depleted bottom waters. Hindcasts show hypoxic areas of 1,930 to 3,860 square miles from 1973 to 1975, minimal hypoxia in 1976 and 1977, and significant and persistent large-scale hypoxia regions between 1978 and 1985.



The Federal-State-Tribal Action Plan for reducing, mitigating, and controlling hypoxia in the northern Gulf of Mexico (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, 2001) agreed on a goal to reduce the 5-year running average of hypoxic area to less than 1,930 square miles by 2015. The plan suggested that a 30% reduction from the 1980 to 1996 average nitrogen load would be needed to achieve that objective and that most of the reduction would have to come from nonpoint sources as far as 620 miles north of the Gulf. The target reduction was based on current scientific information available and is similar to nutrient-reduction goals in other coastal systems in the United States (Boesch, 2002). This new model, however, suggests that a 30% reduction might not be sufficient to reach this goal in some years, and that it may take a reduction of 40% to 45% to ensure the reduction is attained (see figure below). Data collection and quantitative analyses should be continued if the success of the planned action to reduce nitrogen loading is to be determined, thereby improving future action plans.

For more information, visit http://www.nos.noaa.gov/products/pubs_hypox.html.



Effects of Reduced Nitrogen Load (Scavia et al., 2003).



Benthic Index

The condition of benthic communities in Gulf Coast estuaries is fair to poor. The composition of benthic invertebrate communities reflects long-term exposure to sediment condition in estuaries. Short-term changes in benthic communities occur in response to hypoxic events and disturbances. Indices of biotic integrity have been developed for aquatic systems to describe the condition of biotic communities. Engle and Summers (1999) developed a benthic index of

condition for Gulf Coast estuaries. The benthic index integrates measures of diversity and populations of indicator species to distinguish between degraded and reference benthic communities. Benthic index estimates based on NCA 2000 surveys indicate that 17% of the estuarine area has degraded benthic resources (Figure 5-16). Most estuarine regions in the Gulf Coast showed some level of benthic degradation. Poor benthic condition co-occurred most often with poor water quality and poor sediment quality (Figure 5-17).

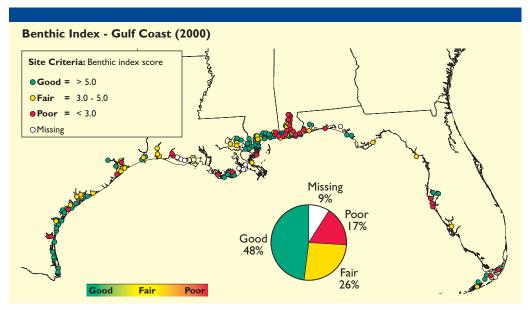


Figure 5-16. Benthic index data for Gulf Coast estuaries (U.S. EPA/NCA).

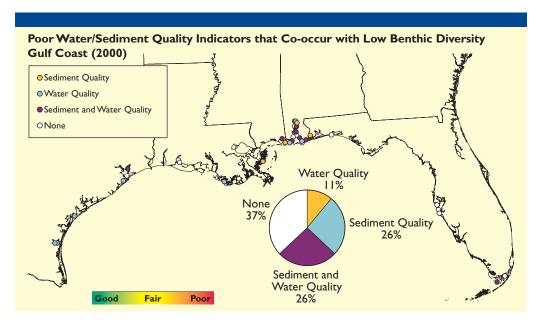


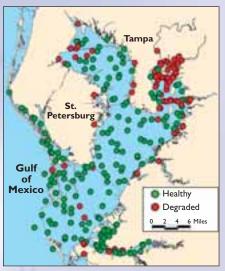
Figure 5-17. Locations in Gulf Coast estuaries where poor benthic condition co-occurred with poor sediment condition, low dissolved oxygen concentrations, or poor water clarity (U.S. EPA/NCA).



Using a Benthic Condition Index to Set Sediment Quality Targets in Tampa Bay, Florida

Identification and remedial treatment of contaminated sediments are among the major priorities of the Tampa Bay Estuary Program (TBEP) (Long et al., 1994). Tampa Bay is a large, urbanized estuary in west-central Florida that is subject to the input of chemical contaminants, including metals, organochlorine pesticides, and the organic chemicals PCBs and PAHs (Zarboch et al., 1996). However, the overall benthic condition of the bay is good, with low dissolved oxygen conditions and elevated contaminants typically found in only a few areas.

During the past 7 years, TBEP partners and a national advisory group have worked together to implement a probabilistic benthic monitoring program based on the EMAP design and to develop narrative and numerical sediment quality targets for key indicators



Sampling locations in Tampa Bay (TBEP, 2003, unpublished data).

of sediment quality. One specific goal was to develop a benthic condition index (BCI) specific to Tampa Bay. This would allow TBEP to establish sediment quality guidelines based on the diversity and abundance of the benthos, as opposed to using costly and time-consuming chemical analysis.

The newly developed BCI will successfully classify sediments as healthy or degraded based on the observed benthos and will serve as a guide from which appropriate management decisions can be made. The BCI will be a refinement of an existing Tampa Bay Benthic Index (Grabe et al., 2002) that incorporates adjustments for salinity based on the work of Engle and Summers (1999). The Tampa Bay BCI was found to have a 90% dissolved oxygen success rate for classifying healthy and degraded samples based on benthos and dissolved oxygen concentration. It also classified 48% of the benthic samples into an intermediate category between healthy and degraded. For each intermediate sample, a numerical BCI value was calculated to quantify whether the sample was closer to a healthy or a degraded condition.

The TBEP is currently working on approaches to incorporate this revised BCI into a sediment quality target-setting process. One promising approach under consideration is to base sediment quality targets on the estimated geographic extent of healthy and degraded habitats and to track the magnitude and trends of these extents annually. The geographic extent, number of samples, and benthic condition of the intermediate samples (i.e., those between a healthy and degraded condition) could similarly be tracked over time. Together, these target-setting metrics can provide the status of degraded habitats and an early warning system to detect healthy habitats moving towards a degraded condition before they become fully degraded.

For more information, visit http://www.tbep.org



Coastal Habitat Index

The coastal wetlands indicator for the Gulf Coast is rated poor. Coastal wetlands, as defined here, include only estuarine and marine intertidal wetlands (e.g., salt and brackish marshes, mangroves and other shrub-scrub habitats, intertidal oyster reefs, and tidal flats, such as macroalgal flats, shoals, spits, and bars). This indicator does not include subtidal SAV, coral reefs, subtidal oyster reefs, worm reefs, artificial reefs, or freshwater/ palustrine wetlands. From 1990 to 2000, the Gulf Coast region experienced a loss of 7,750 acres of estuarine wetlands (Figure 5-18). The long-term, average decadal coastal wetlands loss rate is 2.5%. Averaging these two loss rates and multiplying by 100 results in a coastal habitat index value of 1.30. Gulf Coast coastal wetlands constitute 66% of the total estuarine wetland acreage in the conterminous 48 states. Although the Gulf sustained the largest net loss of estuarine wetlands in the last decade compared with

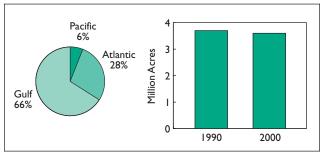


Figure 5-18. Estuarine intertidal wetland estimates for the Gulf Coast as acreage in 2000 and change in acreage from 1990 to 2000 (Dahl, 2003).

other regions of the country, the Gulf Coast region also has the greatest total acreage of estuarine wetlands (3,769,370 acres). Coastal development, sea-level rise, subsidence, and interference with normal erosional/ depositional processes contribute to wetland loss along the Gulf of Mexico coast.



Fish Tissue Contaminants Index

Estuarine condition in Gulf Coast estuaries based on concentrations of contaminants in fish tissues is rated fair. Figure 5-19 shows that 14% of all sites sampled where fish were caught exceeded the risk-based guidelines used in this assessment. (Whole-fish contaminant concentrations can be higher or lower than the concentrations associated with fillets only. Only those contaminants that have an affinity for muscle tissue, e.g., mercury, are likely to have higher fillet concentrations. Fillet contaminant concentrations for most other contaminants will likely be lower.) However, for some populations that consume whole fish, these risk calculations are appropriate. Contaminant concentrations exceeding EPA guidance levels were observed in Atlantic croaker, some catfish, scianids, pigfish, pinfish, and shrimp. In Gulf Coast estuaries, the observed contaminants included total PCBs and DDT, and occasionally, cadmium, dieldrin, and mercury.

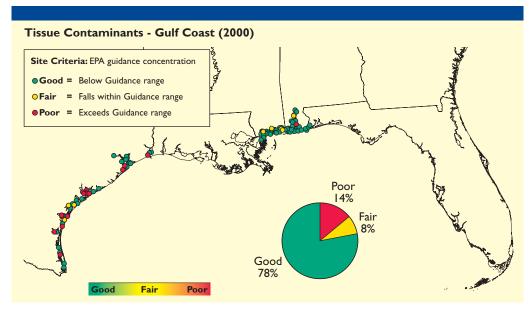


Figure 5-19. Fish tissue contaminants data for Gulf Coast estuaries (U.S. EPA/NCA).

Large Marine Ecosystem Fisheries

The Gulf of Mexico LME bordering the United States includes diverse habitats ranging in salinity, flora, and fauna. It includes freshwater and estuarine habitats, nearshore and barrier islands, and oceanic communities. Watersheds contributing to the Gulf of Mexico LME drain the vast interior of the continent, including the piedmont and coastal plains as far north as the headwaters of the Missouri and Mississippi rivers. Along the coasts of western Florida, Alabama, Mississippi, Louisiana, and Texas, fresh water from upland regions mixes with prevailing oceanic waters in the Gulf of Mexico to create diverse wetland, marsh, and mangrove habitats that transition from freshwater to brackish to saltwater. This thin fringe of estuaries is very dynamic, with constant tidal fluctuations and varying levels of runoff. It serves as an important habitat for waterfowl, reptiles, mammals, fish, invertebrates, and a diversity of plants, and as a natural filter to remove pollutants and sediments from upland regions. It also maintains diverse aquatic communities and complex food webs in an irreplaceable nursery system that supports the recruitment and development of juvenile fish and invertebrate species that are important to recreational, commercial, and ecological interests.

Estuarine and inshore regions are largely buffered from the destructive effects of winds, waves, and occasional hurricanes by a long, thin system of barrier islands extending roughly end-to-end from western Florida to Texas. This natural system is composed primarily of unconsolidated sand, shell, and gravel deposited and redeposited through erosion and accumulation by the dynamics of prevailing oceanic currents, winds, and storms. A well-developed barrier island can produce and support a variety of habitats, ranging from coastal marine beach and maritime marsh on the seaward and inshore sides, to fresh or brackish marsh in the low inland areas, to dunes, shrubs, and forests in the upland areas.

The Gulf of Mexico LME beyond the continental shelf is a semi-enclosed oceanic basin connected to the Caribbean Sea by the Yucatan Channel and to the Atlantic Ocean by the Straits of Florida. Through the narrow but deep Yucatan Channel, a warm current of water flows northward, penetrating the Gulf of Mexico LME and looping around or turning east before leaving the Gulf through the Straits of Florida. This current of tropical Caribbean water is known as the Loop Current, and along its boundary, it produces numerous eddies, meanders, and intrusions that affect much of the hydrography and biology of the Gulf. A diversity of fish eggs and larvae are transported in the Loop Current, and the innumerable eddies, meanders, convergences, and divergences along the current's boundary tend to concentrate and transport early life stages of fish toward estuarine nursery areas, where the young can reside, feed, and develop to maturity.



Bearded fireworms can erect their venomous white bristles at the approach of a diver or other predator (Pat Cunningham).

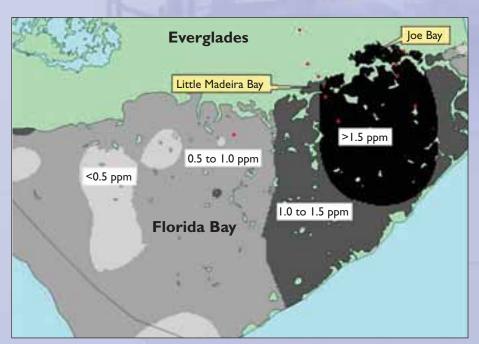
highlight

Florida Bay Mercury Study

The EPA's GMP report, A Survey of Mercury in the Fishery Resources of the Gulf of Mexico, identified two regional concentrations for mercury accumulation in fish from the Gulf of Mexico. One of these locations, Lavaca Bay, Texas, was highlighted in the previous National Coastal Condition Report. The extensive mercury contamination in Lavaca Bay is derived from an inactive chlor-alkali production facility.

The second concentration, located in Florida Bay, Florida, lies entirely within Everglades National Park. Surprisingly, there is no significant industrial source of mercury to Florida Bay. High mercury concentrations observed in fish from the Florida Bay are thought to be a result of natural conditions in Florida Bay and its Everglades watershed, which favors the methylation of inorganic mercury entering through nonpoint source runoff and atmospheric deposition. The area is currently under a fish consumption advisory. Gamefish such as spotted sea trout and jack crevalle have shown the highest mercury levels, with red drum, snook, and gray snapper also accumulating mercury to levels of concern.

The NOAA's Center for Coastal Fisheries and Habitat Research, Beaufort, North Carolina, and the South Florida Water Management District initiated a cooperative project to understand the sources of these high mercury concentrations. Studies have shown that the high mercury concentrations center in the region where fresh water from the Everglades enters the eastern



Mercury concentrations observed in spotted sea trout from Florida Bay. Two transects through the mangrove transition zone at Little Madeira Bay and Joe Bay sampled possible inputs of mercury from the Everglades (graphic provided by David W. Evans, NOAA).

portion of Florida Bay. Much of the freshwater habitat of the Everglades is also under a fish consumption advisory because of high mercury concentrations. This finding initially suggested that freshwater runoff was the dominant source of elevated mercury concentrations.

Researchers conducted two surveys of this region to sample for mercury in water, sediments, and fish and found that the watershed was not the only source of methylmercury contamination in fish. The mangrove transition zone that separates the terrestrial Everglades from Florida Bay produced the highest total mercury and methylmercury concentrations in water and sediments. The USGS measured the rate of mercury methylation in sediment samples and found significant methylmercury production occurring in the watershed, mangrove transition zone, and the bay itself. Methylmercury in water mixes among these three source areas, and the exposed fish that move amidst these source areas accumulate methylmercury through feeding. Through this cycle, fish from throughout eastern Florida Bay have bioaccumulated mercury in their tissues at levels of concern.

Such mercury concentrations in fish seem to have changed little over the past decade. This suggests that local reductions in atmospheric mercury emissions have not translated into mercury reductions in fish. Interest remains toward determining the properties of Florida Bay and the environs that contribute to these surprisingly high natural concentrations of mercury in fish. These concentrations may pose health risks for both human and wildlife consumers of fish from Florida Bay.

For more information, contact David Evans at david.w.evans@noaa.gov.



Gray snapper in the mangrove transition zone (Don Demaria).

Reef Fish Resources

Combined commercial and recreational landings of the reef fishes from the U.S. Gulf of Mexico LME have fluctuated since 1976 and show a slightly increasing trend over time. Meanwhile, fishing pressure in this region has increased significantly. The NOAA's Reef Fish FMP prohibits the use of fish traps, roller trawls, and powerheads on spearguns within an inshore stressed area; places a 15-inch total length minimum size limit on red snapper; and imposes data-reporting requirements. The red snapper fishery has been under stringent management measures since the late 1990s. A stock rebuilding plan proposed in 2001 provides (1) a 4,137-mt quota, and (2) bag limits, size limits, and commercial and recreational seasons. This plan, which will remain in effect until 2005, should provide stability and predictability in this important fishery for both industry and consumers. A 20% spawning-potential ratio was established as a basis to measure overfishing. Other regulations pertaining to the management of reef fishes within the U.S. Gulf of Mexico LME include minimum size limits, permitting systems for commercial fishermen, bag limits, quotas, seasonal closures, and the establishment of Marine Protected Areas that prohibit the harvest of any species.

Of the dominant reef fishes within the U.S. waters of the Gulf of Mexico LME, the red snapper and red grouper stocks are currently overfished, and the gag and greater amberjack stocks are approaching an overfished condition. The regulatory measures and stock rebuilding plans currently under way are designed to reduce fishing mortality and to continue or begin rebuilding all these stocks.

Reef species form a complex, diverse, multispecies system. The long-term harvesting effects on reef fishes are not well understood and require cautious management controls of targeted fisheries, as well as bycatch from other fisheries within the U.S. waters of the Gulf of Mexico LME.

Menhaden Fishery

Landings records in the Gulf Coast menhaden fishery date back to the late 1800s, although data to World War II are incomplete. During the 1950s through the 1970s, the fishery grew in terms of numbers of reduction plants and vessels, and landings generally increased with considerable annual fluctuation (Figure 5-20). Record landings of 982,800 mt occurred in 1984. Landings subsequently declined to a 20-year low of 421,400 mt in 1992. The decline in landings was primarily due to low product prices, consolidation within the menhaden industry, and a concurrent decrease in fishing effort, vessels, and fish factories in the northern Gulf of Mexico LME. Landings in recent years (1998–2002) are less variable, ranging between 486,200 and 684,300 mt (574,500 mt in 2002). Historically, Gulf Coast menhaden fishing ranged from the Florida Panhandle to eastern Texas. Currently, the fishery ranges from western Alabama to eastern Texas, with about 90% of the harvest occurring in Louisiana waters.

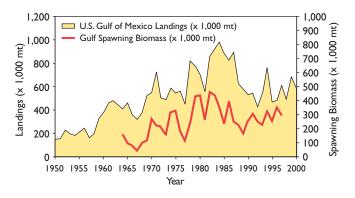


Figure 5-20. Landings and spawning biomass of Gulf Coast menhaden, 1950-2000, in metric tons (mt) (NMFS, 2003).

The 1999 assessment indicates that the menhaden stock is healthy and that catches are generally below long-term maximum sustainable yield estimates of 717,000 mt to 753,000 mt. Comparison of recent estimates of fishing mortality to biological reference points does not suggest overfishing. In 2003, four factories were processing Gulf Coast menhaden in the northern Gulf of Mexico LME (one in Mississippi and three in Louisiana), with a total of about 40 steamers.

Mackerel Fisheries

Total catch of Gulf Coast king mackerel averaged 3,467 mt per fishing year from 1981 to 2000, with a maximum of 5,599 mt (1982) and a minimum of 1,368 mt (1987). In 2001, total catch was 3,649 mt, with the recreational sector accounting on average for 62% of the total catch and the commercial sector for 38%. From 1986 to 1996, the landings were consistently above the total allocated catch, and by 1997, the Gulf of Mexico Fisheries Management Council increased the total allocated catch to 4,812 mt. Landings have oscillated about 3.882 mt in the last 4 years. The 2002 stock assessment indicated that the stock is currently fished at a rate near or at the maximum fishing mortality threshold, and the stock spawning biomass was slightly above the minimum stock-spawning threshold. The Mackerel Stock Assessment Panel concluded that the stock was not overfished or undergoing overfishing, although it recommended that fishing mortality rates be decreased to avoid a high risk of overfishing or overfished status in coming years. At present, the commercial fishery for Gulf of Mexico LME king mackerel has restrictions on minimum size, regional quota allocations, and trip catch limits, as well as gear restrictions. The recreational fishery is regulated with restrictions on minimum size and bag limits for Gulf of Mexico LME king mackerel.

Total catch of Gulf Coast Spanish mackerel averaged 2,081 mt per fishing year from 1984 to 2001, with a maximum of 4,586 mt (1987) and a minimum of 995 mt (1996). Catches dropped substantially (about 50%) in 1995-1996 because of the gill-net ban in Florida waters, where a major portion of the commercial catch took place. In 2001, total catch was 1,737 mt, with on average, a split of 54% from the recreational and 46% from the commercial sectors. Since 1989, the landings of Gulf Coast Spanish mackerel have been consistently below the total allocated catch, and since 1995, total landings have been about 50% of the total allocated catch. The 2003 stock assessment indicated that the stock is currently exploited at the optimum long-term yield level. At present, management restrictions for the commercial fishery of Gulf Coast Spanish mackerel include minimum size restrictions and quota allocation, plus gear restrictions in state waters. For the recreational fishery, minimum size and daily bag restrictions are in place. Current issues affecting this stock involve mainly the bycatch of juveniles in the shrimp trawl fishery.

Shrimp Fisheries

A general fluctuating increase in catch per unit effort (CPUE) was observed for white and brown shrimp from the late 1980s to 2001 (Figure 5-21). Between 1960 and the late 1980s, stocks of brown, white, and pink shrimp had generally shown a decline. A commercial shrimp-harvesting permit system for federal waters was initiated in 2001, with a proposed control date of December 2003. The Gulf of Mexico Fisheries Management Council is considering additional management measures, including measures that would potentially limit entry into the shrimp fishery. Current research is assessing the integrity of the shrimp stocks, as well as the overall economic well-being of the industry.

The most current status of Gulf of Mexico LME shrimp populations in U.S. waters is indicated by the 2000 and 2001 landing statistics. Catch rates of both brown and white shrimp populations were at high levels for the 2001 harvesting season. The 2001 CPUE for brown shrimp was near record levels, equaling 612 lbs/day. White shrimp CPUE for 2001 was also high at 416 lbs/day. Pink shrimp CPUE for 2000 was near the levels seen in the early 1990s. The current CPUE relative to historic levels, as well as the spawning population size indices, reveal no evidence of overfishing occurring within these populations.

All three of the commercial shrimp species are being harvested at maximum levels. Maintenance of shrimp stocks above the overfishing index levels should prevent overfishing of these populations. Because it has been shown that environmental factors determine production, negative effects on habitat have the potential to cause future reductions in shrimp catch. The loss of habitat, such as the destruction of wetland nurseries and the expanding dead zone in Louisiana, may cause declines in the shrimp harvest.

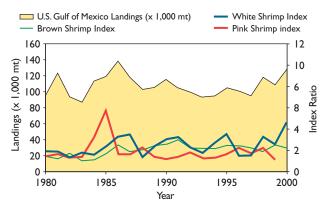


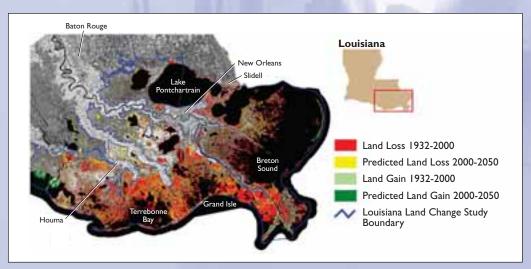
Figure 5-21. Gulf of Mexico shrimp landings, 1980–2000, in metric tons (mt) (NMFS, 2003).

highlight

Coastal Louisiana: America's Vanishing Wetlands

The Louisiana coastline was formed by sediment the Mississippi River carried down from 31 states and 2 Canadian provinces. The Mississippi River Watershed covers 41% of the lower 48 states; however, many factors have led to massive land losses to our nation's most productive coastlines, including actions taken upriver to improve public safety and the welfare of the heartland's economy, our nation's energy needs, global warming impacts, and land subsidence. According to the USACE, dams, levees, and navigation projects built along the Mississippi River's mainstream and major tributaries have resulted in a 67% decrease in sediment delivered to these coastlines. Coincidently, following the flood of 1927, navigation projects upriver, which were started in 1928 and completed in 1963, correspond to the first observations of major coastal land loss.

USGS data, generated in conjunction with the Louisiana Department of Wildlife and Fisheries, indicate that 878,000 acres of fresh marsh, 1.63 million acres of nonfresh marsh, and 1.15 million acres of forested and scrub/shrub wetlands make up a total of 3.7 million acres of coastal wetlands. Within the lower 48 states, Louisiana accounts for 30% of all coastal marshes, 45% of intertidal coastal marshes, and 14% of coastal wetlands (marshes, mangroves, and forests).



100+ years of land change for southeastern coastal Louisiana (Barras et al., 2004)

Within the last 70 years, Louisiana has lost more than 1.22 million acres of coastal wetlands. A new USGS model predicts that another 448,000 acres will vanish into the Gulf of Mexico in the next 50 years. The map of the Mississippi River delta shows the area where more than 70% of this loss has occurred in coastal Louisiana over the last 120 years. This loss exceeds the combined land area of the state of Delaware, the District of Columbia, and the Baltimore, Maryland, metropolitan area. On a national scale, Louisiana experiences about 90% of the total coastal marsh loss in the lower 48 states. These losses foreshadow serious natural resource problems and a societal and economic catastrophe, not only for Louisiana, but also for the entire nation.

Coastal Louisiana wetlands lie at the heart of an intricate ecosystem on the verge of collapse. These wetlands support the largest commercial fishery in the lower 48 states. They provide wintering habitat for millions of waterfowl and migratory birds, as well as a home for several endangered and threatened species. Coastal Louisiana maintains 20 national wildlife refuges and 2 national parks totaling more than 192,000 acres. Some of these areas are experiencing wetland losses that affect their capacity to support fish and wildlife.

A quarter of the nation relies on Louisiana wetlands as natural protection from storms and hurricanes for both people and property. The loss of these wetlands as a buffer could devastate the nation's energy security. Coastal Louisiana is the home of two U.S. Strategic Oil Reserve Sites (a necessity during national emergencies), encompassing thousands of miles of pipelines, numerous refineries, and gas production facilities. These resources provide heat and fuel to public homes and automobiles.

To address this enormous wetland loss issue, the state of Louisiana and the USACE, along with other federal and state partners, are conducting the Louisiana Coastal Area Comprehensive Coastwide Ecosystem Restoration Study. The goal of this effort is to develop a coast-wide comprehensive plan intended to sustain the coastal ecosystem. This ecosystem supports and protects the environment, economy, and culture of southern Louisiana and contributes to the economy and well-being of the nation. Final reports from this effort will be submitted to the U.S. Congress in fiscal year 2004 for authorization of a \$14 billion effort.

For additional information and status of the study, please visit http://www.lacoast.gov.

highlight

Restoration of the Florida Everglades

The NMFS is working with the state of Florida, separate federal agencies, and local Native American tribes in an initiative to restore the Florida Everglades and its associated coastal ecosystems, including Florida Bay and the Florida Keys reef tract. The South Florida Ecosystem Restoration Initiative affects many of Florida's natural resource treasures, including Everglades National Park, Biscayne National Park, Dry Tortugas National Park, Big Cypress National Preserve, the Florida Keys National Marine Sanctuary, Rookery Bay National Estuarine Research Reserve, and Corkscrew Swamp Sanctuary.

The Comprehensive Everglades Restoration Project (CERP) is the initiative's congressionally mandated core program led by the USACE and the South Florida Water Management District. CERP's major objective is to restore the vitality and productivity of the remaining natural areas of South Florida. This involves integrated projects to redesign the Central and Southern Florida Flood Control Project. Uncertainty exists about Florida's original (pre-1870) hydrological framework, as well as those characteristics most responsible for maintaining former landscape patterns and the diversity and abundance of native plants and animals. CERP's goal is to reconstitute the natural hydrologic regime to Florida's wetlands and to



Florida Bay mangrove area.

replenish the quantity, quality, timing, and spatial distribution of freshwater flow to estuaries. Adaptive management, a science-based strategy involving modeling and monitoring of performance measures, is being applied to determine whether system responses are achieving these goals.



Pink shrimp can be substantially affected by the range of the Florida Bay's salinity.

Performance measures are calculable indicator characteristics that provide a quantitative sign of change. Indicators and performance-measure targets are being used to define goals and to determine whether CERP restoration efforts are being achieved. Water resource management for estuaries such as Florida Bay requires ecological performance measures that are applied, through modeling, to predict the effect of alternative design strategies and, through monitoring, to assess the effects of these projects once implemented. The NMFS is developing these ecological performance measures

and predictive models to protect and restore essential fish habitats, a major NMFS mandate. The NMFS focus has been on key fishery species, such as pink shrimp, spotted sea trout, and gray snapper, which use estuaries such as Florida Bay as nursery grounds. Performance measures are also being developed for protected species, such as bottlenose dolphin, and a community of prey species, such as dolphin, wading birds, and game fish, which help transfer energy from primary producers to higher trophic-level species.

Developing a performance measure goes beyond the mere formulation of a metric, requiring an analytical understanding of ecological indicators so that any changes may be measured and interpreted correctly. For example, statistical analyses by NMFS researchers have suggested that pink shrimp harvests in the Dry Tortugas are influenced by freshwater inputs to Florida Bay. Adult pink shrimp spawn near the Tortugas, where they support a multi-million dollar fishery, but juvenile pink shrimp develop in Florida Bay and other southwest coastal estuaries. NMFS researchers, using a simulation model and laboratory tests, have determined that growth and survival of juvenile pink shrimp can be substantially affected by the range of the bay's salinity

variation, thus identifying one possible link between harvests and freshwater inputs. NMFS and USGS researchers are sampling pink shrimp postlarval stages on both sides of Florida Bay to identify pathways and processes affecting immigration rates. Behavior may also be a factor because shoreward movement of juveniles on tidal currents is facilitated by the juvenile shrimp migrating vertically in the water column (up on the flood tide and down on the ebb tide). The salinity gradient is one possible behavioral cue guiding this vertical movement.



Adult pink shrimp spawning areas.

EPA's focus has been on the development of performance measures relative to water quality indicators. Phosphorus is an indicator of concern in freshwater wetlands, whereas nitrogen is the important indicator in some South Florida estuaries. Contaminants may also be detrimental to the CERP restoration effort. South Florida's hydrologic system has been physically altered to such an extent that correctly managing the water for estuaries may not automatically follow management procedures for upstream wetlands. Special design features may be necessary to provide fresh water in the right quantity and quality, at the right time, and at the right location to protect and restore estuaries. Performance measures will help make this possible.

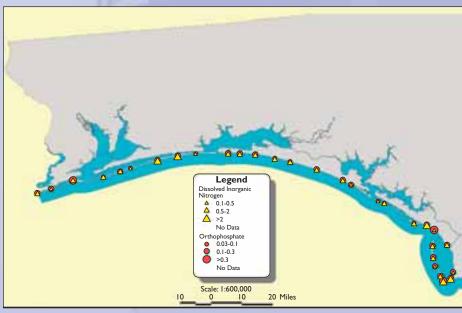
For more information, contact Nancy Thompson at nancy.thompson@noaa.gov.

highlight

A Pilot Study Assessing Beach Conditions in Northwest Florida

Gulf Coast beaches are a valuable local, regional, and national resource. Protection of this resource for recreation and other purposes is an important goal for resource managers. Using an approach similar to EPA's EMAP, EPA's Gulf Ecology Division conducted a pilot shoreline monitoring survey along the Florida Panhandle during August and September, 1999. The study area covered a stretch of coastline from Perdido Key to Port St. Joe, Florida, and included public beach areas. Researchers collected hydrographic data and water chemistry samples at 30 sites selected using a probability-based survey design. Bacterial indicators, enterococci, and fecal coliforms were enumerated in beach water samples according to the EPA Beaches Environmental Assessment, Closure, and Health (BEACH) Program and Florida State guidelines.

EPA developed the BEACH Program to reduce the risk of human illness associated with pathogens found at the nation's beaches and recreational waters through improved recreational water protection programs, risk communication, and scientific approaches. BEACH grants support the development and implementation of programs to inform the public about the risk of exposure to disease-causing microorganisms in the waters of our nation's beaches. The pilot study also measured additional indicators that included the presence or absence of primary and secondary dunes, anthropogenic debris, and vegetation.



Concentrations of DIN and orthophosphate measured at northwest Florida beaches (U.S. EPA/NCA).

Using EMAP evaluation guidelines and Florida state criteria for Class III swimmable waters, the survey indicated that more than 90% of the coastal beach area of northwest Florida met criteria for designated uses. Bacterial indicators are the major criteria for the protection of human health. Additional criteria for the ecological assessment of coastal beaches is lacking due to gaps in data. Such baseline data can help to determine if coastal areas meet designated uses and provide a comparative tool for evaluating future conditional trends from both a human health and an ecological perspective. Even if designated uses are currently met, resource managers must continue to monitor these waters to evaluate the potential for future problems, such as nutrient overenrichment and fecal contamination. These problems can affect not only recreational beaches, but all shorelines. This pilot study demonstrates that the application of a probabilistic sampling design is a valuable procedure for assessing coastal shoreline condition.



Beach monitoring of bacterial contamination protects public health (U.S. EPA, Gulf Breeze Florida Laboratory).

Assessment and Advisory Data

Clean Water Act Section 305(b) **Assessments**

Gulf Coast states assessed 11,219 (71%) of the 15,857 square miles that make up the Gulf Coast estuaries for their 2000 305(b) reports. The 2000 305(b) reports are generally based on data collected in the late 1990s. Although Florida reports water quality information for coastal waters, it is not possible from that report to distinguish between Atlantic and Gulf Coast listings; therefore, 305(b) assessment information for Florida is included in its entirety in this section. Forty-one percent of the assessed estuarine waters on the Gulf Coast fully support their designated uses, and 2% are threatened for one or more uses (Figure 5-22). The remaining 57% of assessed estuarine waters on the Gulf Coast are impaired by some form of pollution or habitat degradation. Individual use support for estuaries is shown in Figure 5-23 and Table 5-1.

Mississippi is the only Gulf Coast state that reported on its coastal shoreline. Mississippi assessed 94 miles, which is 1% of the Gulf Coast's 10,063 coastal shoreline miles. The other Gulf Coast states do monitor and assess their coastal waters, but they chose an alternate reporting method to meet their 305(b) requirements. Individual use support for assessed shoreline in Mississippi is shown in Figure 5-24. Individual use support for assessed coastal waters reported by Mississippi is shown in Table 5-1.

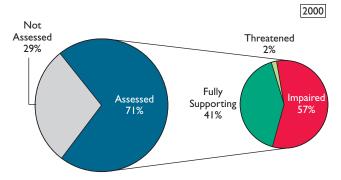


Figure 5-22. Water quality in assessed Gulf Coast estuaries (U.S. EPA, 2002).

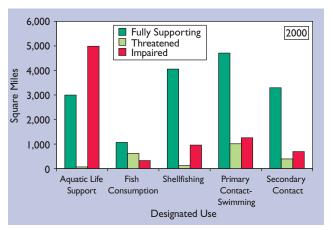


Figure 5-23. Individual use support in assessed Gulf Coast estuaries (U.S. EPA, 2002).

Table 5-1. Individual Use Support for Assessed Coastal Waters Reported by the States on the Gulf Coast under Section 305(b) of the Clean Water Act for 2000 (U.S EPA, 2002).

Individual Uses	Assessed Estuaries Impaired (mi ²)	Assessed Shoreline* Impaired (mi)
Aquatic life support	4,994 (62%)	0
Fish consumption	327 (17%)	0
Shellfishing	945 (18%)	89 (100%)
Primary contact – swimming	1,256 (18%)	26 (18%)
Secondary contact	687 (16%)	26 (81%)

^{*}Data from Mississippi only

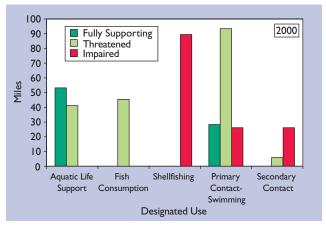


Figure 5-24. Individual use support for assessed shoreline waters in Mississippi (U.S. EPA, 2002).

Fish Consumption Advisories

In 2002, 13 fish consumption advisories were in effect for the estuarine and marine waters of the Gulf Coast. Most of the advisories (12) were issued for mercury, and each of the five Gulf Coast states had one statewide coastal advisory in effect for mercury in king mackerel (for fish longer than 39 inches). The statewide king mackerel advisories covered all coastal and estuarine waters in Florida, Mississippi, and Alabama, but covered only coastal shoreline waters in Texas and Louisiana. As a result of the statewide advisories, 100% of the coastal miles of the Gulf Coast and 23% of the estuarine square miles were under advisory in 2002 (Figure 5-25).

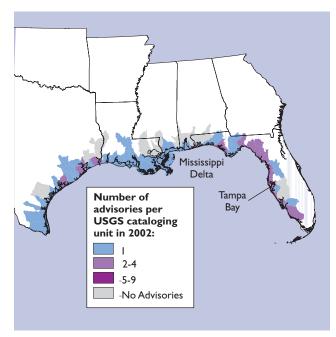


Figure 5-25. The number of Gulf Coast fish consumption advisories active in 2002 (U.S. EPA, 2003c).

Summary of fish and shellfish under human consumption advisories for at least some part of the Gulf Coast:				
Barracuda	King mackerel			
Blue crab	Ladyfish			
Bluefish	Little tunny			
Catfish	Permit			
Crab	Red drum			
Cobia	Shark			
Gafftopsail catfish	Snook			
Gag grouper	Spanish mackerel			
Greater amberjack	Spotted seatrout			
Crevalle jack	Wahoo			
	Source: U.S. EPA, 2003c			

Fish consumption advisories placed on specific waterbodies included additional fish species (Figure 5-26). Florida had eight mercury advisories in effect for a variety of fish, in addition to the statewide coastal advisory. In Texas, the Houston Ship Channel was under advisory for catfish and blue crabs because of the risk of contamination by dioxins.

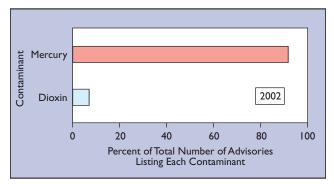


Figure 5-26. Percentage of estuarine and coastal marine advisories issued for each contaminant on the Gulf Coast. An advisory can be issued for more than one contaminant, so percentages may not add up to 100 (U.S. EPA, 2003c).

Beach Advisories and Closures

Of the 176 coastal beaches in the Gulf of Mexico that reported information to EPA, 36.9% (65 beaches) were closed or under an advisory for some period of time in 2002. Table 5-2 presents the numbers of beaches, advisories, and closures for each state. As shown in the table, Florida's west coast had the most beaches with advisories or closures, and Mississippi did not participate in EPA's 2002 survey. Figure 5-27 presents advisory and closure percentages for each county within each state.

in 2002 for Gulf Coast States (U.S. EPA, 2003a)							
State	No. of Beaches	No. of Advisories/ Closures	Percentage of Beaches Affected by Advisories/ Closures				
Florida (Gulf Coast)	134	52	38.8%				
Alabama	П	4	36.4%				
Mississippi	N/A	N/A	N/A				
Louisiana	T	T	100%				
Texas	30	8	26.7%				
TOTALS	176	65	36.9%				

Most beach advisories and closings were implemented at coastal beaches along the Gulf Coast because of elevated bacteria levels (Figure 5-28). There were multiple sources of water-borne bacteria that resulted in advisories or closings. Stormwater runoff, other sources, and wildlife were frequently identified as sources. Unknown sources accounted for 36 percent of the responses (Figure 5-29).

In Florida, 39% (52 of 134) of beaches responding to the EPA reported that they had issued an advisory or closing at least once during 2002. The primary reasons for public beach notifications were preemptive actions due to rainfall events or the detection of elevated bacteria levels due a variety of sources, including unknown sources, stormwater and other runoff, wildlife, boat discharges, septic systems, and POTW discharges.

In Alabama, 11 coastal beaches responded to EPA's survey, and of these, 4 beaches (36%) reported advisories or closures during 2002 from elevated bacterial levels due to stormwater runoff, unknown sources, wildlife, and sewerline blockage or pipe breakage. In Louisiana, one beach, on the south shore of Lake Pontchartrain, reported being affected by a year-long advisory or closure during 2002 due to elevated bacterial levels from POTWs, sewerline blockage or pipe breakage, and stormwater runoff.

In Texas, 30 beaches reported information to the EPA, and of these, 8 beaches (26%) reported advisories or closures during 2002 due to elevated bacteria levels from unknown sources, stormwater runoff, wildlife, septic systems, boat discharges, sanitary sewer overflows, and sewerline blockage or pipe breakage.



A lime-green lettuce sea slug crawls through a meadow of mermaid's wine glass algae (Pat Cunningham).

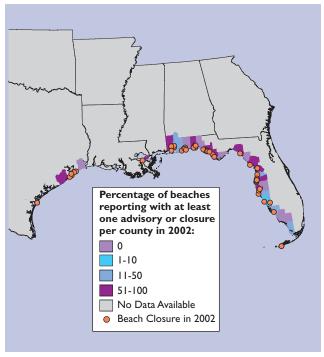


Figure 5-27. Percentage of Gulf Coast beaches with advisories or closures by county in 2002 (U.S. EPA, 2003a).

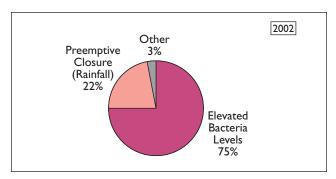


Figure 5-28. Reasons for beach advisories or closures on the Gulf Coast (U.S. EPA, 2003a).

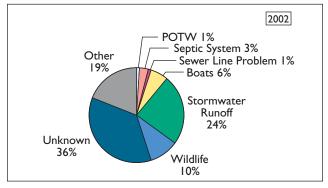


Figure 5-29. Sources of beach contamination on the Gulf Coast (U.S. EPA, 2003a).



Based on the indicators used in this report, ecological conditions in Gulf Coast estuaries are fair. The primary problem in Gulf Coast estuaries in 2000 was coastal wetland loss (rated poor). Fish tissue contaminants, benthic condition, and sediment quality were also of concern (rated fair). Fish tissue contaminant concentrations exceeded risk-based EPA Guidance levels in 14% of sites in Gulf Coast estuaries sampled for fish. These sites were dominated by elevated tissue concentrations of total PCBs and DDT, with some instances of dieldrin, mercury, cadmium, and toxaphene. Benthic index values were lower than expected in 17% of Gulf Coast estuarine sediments, and elevated sediment contaminant concentrations were found in 11% of estuarine sediments. About 2.5% of wetlands were lost per decade from 1780 to 1980, and about 0.25% of wetlands were lost between 1990 and 2000. The water quality index was rated fair (9% of estuarine area in poor condition), with only decreased water clarity and elevated DIP observed in more than 10% of estuarine area (29% and 11%, respectively). Elevated levels of chlorophyll a were observed in 8% of estuaries. DIN and dissolved oxygen concentrations rarely exceeded guidelines. Although conditions in Gulf Coast estuaries were among the worst in the country in 1990, the overall rating of 2.4 in this report is an increase from the rating of 1.9 observed in the early 1990s. Some of this improvement may be the result of modification of the water quality index to include nitrogen, phosphorous, and chlorophyll. Increasing population pressures in this region of the country will require additional monitoring programs and increasing environmental awareness in order to correct existing problems and to ensure that indicators that appear to be in fair condition do not worsen.